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(54) Embossed Dust Mop having Embossed, Nonwoven Fabric Cleaning Element

(57) An embossed nonwoven fabric comprised of a mat of microfibers which may include crimped macrofibers is useful for wiping dust from surfaces. The working face of the fabric is embossed to a limited degree to provide integration of the normally fragile nonwoven fabric web yet not interfere with its cleaning ability. The areas on either side of the working face adjacent the side edges of the fabric preferably are more highly embossed to provide greater structural integrity sufficient to permit handling and installation of the fabric in certain dust mop frames having high shear or other holding means which could damage the fabric.

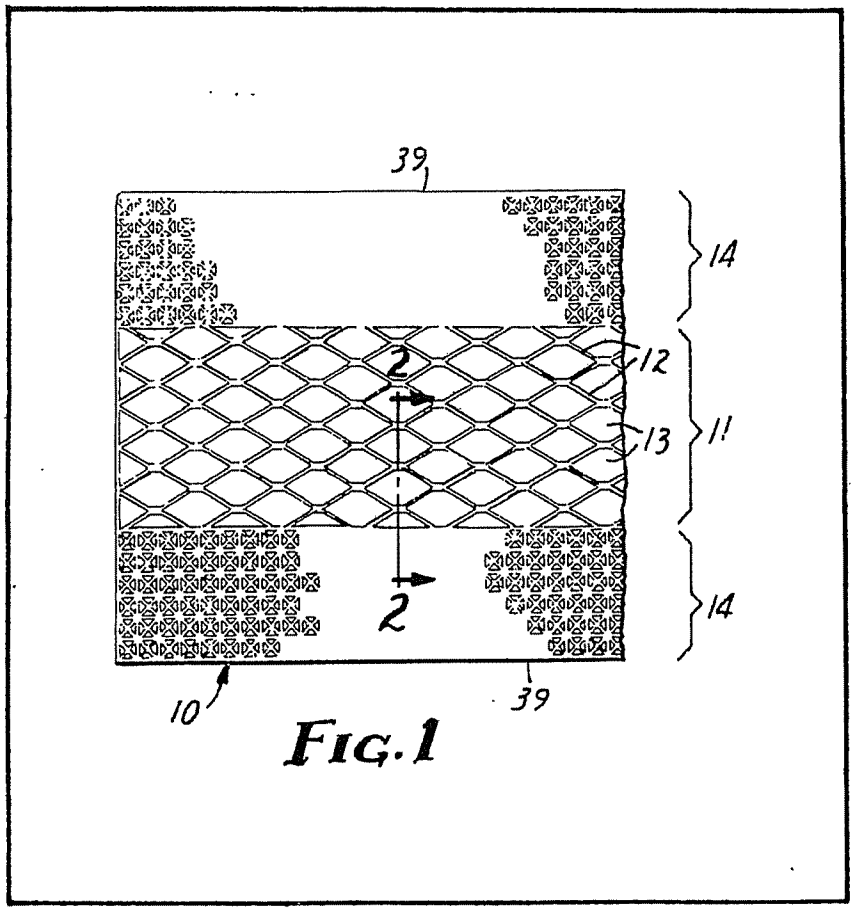

FIG. 1

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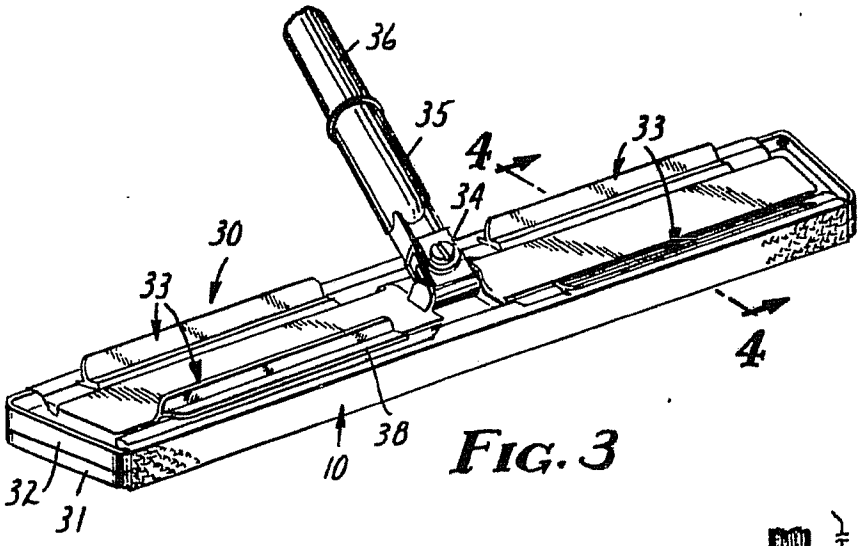
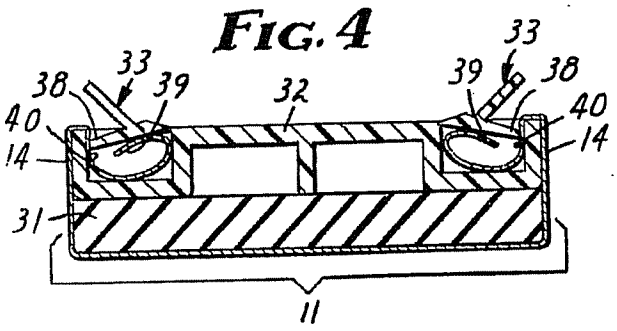


FIG. 3

FIG. 4



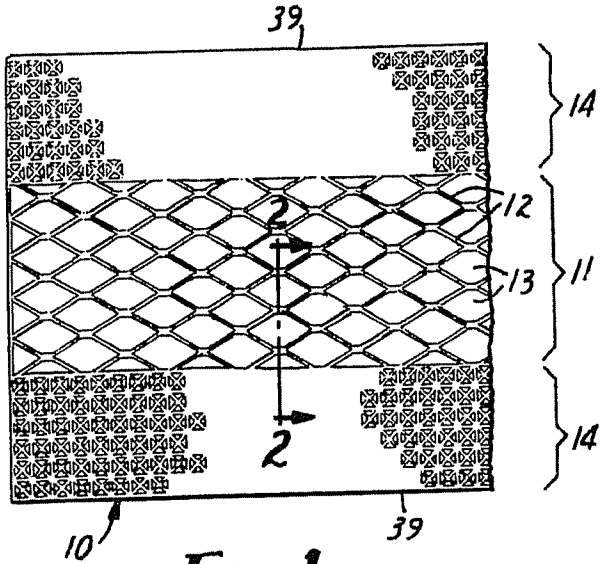


FIG. 1

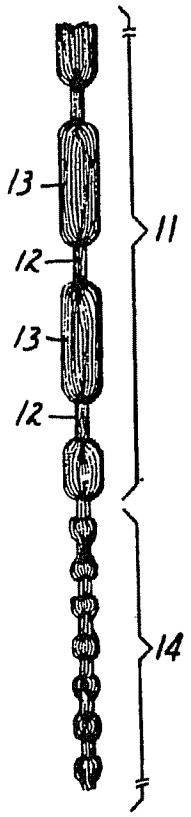


FIG. 2

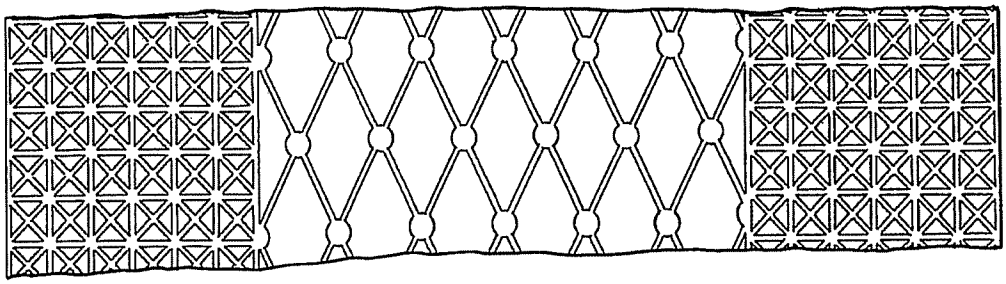


FIG. 5

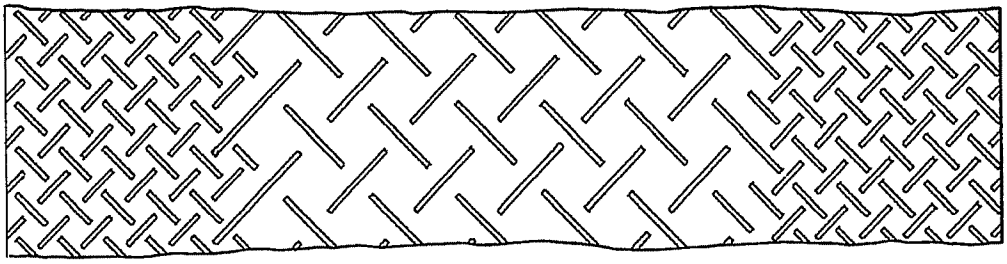


FIG. 6

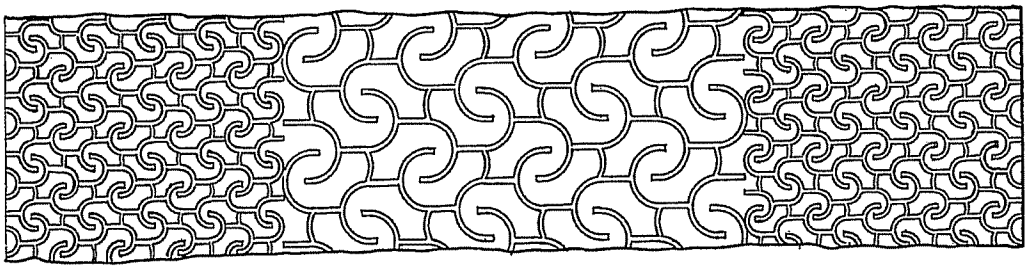


FIG. 7

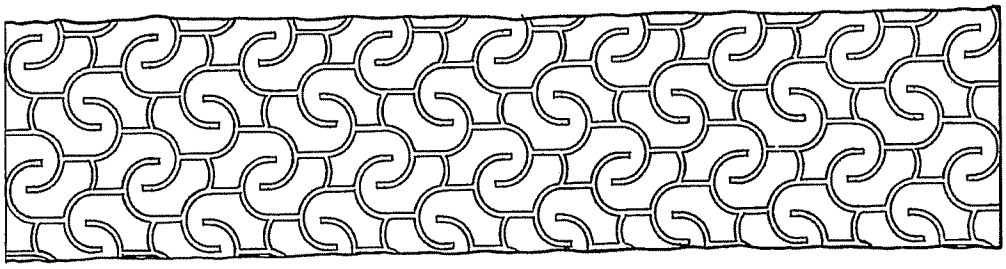


FIG. 8

SPECIFICATION

Embossed Dust Mop Having Embossed, Nonwoven Fabric Cleaning Element

Dust removal from smooth hard surfaces such as floors is a continuing problem both for the homemaker and for professional building maintenance personnel. Such removal is generally accomplished by wiping the surface with a cleaning element such as a fabric which may be held in a frame. Early dust mop cleaning elements were made of fibers such as cotton which may be treated with an impregnant such as oil to give the fibers a higher capacity for collecting dust. Woven and nonwoven fabrics have been employed for this purpose as well as collections of loose fibers. Nonwoven fabrics are preferred because they are relatively inexpensive to produce. Dust collecting elements formed of nonwoven fabric are generally called "disposable" because they are discarded instead of being cleaned and reused.

Not all nonwoven fabrics are suitable candidates for use as dust collecting elements. Some fabrics will not attract dust particles because of their physical nature while others are highly attractive. Some nonwoven fabrics are too compacted or dense to provide sufficient openness for dust collection. Some fabrics are too weak to be employed and disintegrate as they are passed over the surface being cleaned and thus may leave unsightly residues of the fabric itself.

It is generally recognized that most nonwoven fabrics cannot be employed *per se* as a dust collecting element without integration by embossing, adhesive bonding or other means to improve their structural integrity. Without such integration, most nonwoven fabrics will disintegrate after only a short period of use as a dust collecting element.

Integration by adhesive bonding is not preferred because it coats the fibers thereby interfering with their dust collecting ability. Certain embossing techniques are also undesirable because they either weaken the fabric or they consolidate it too much thereby reducing its dust collecting ability.

An improved disposable dust collecting fabric is provided by the present invention by an embossed nonwoven fabric comprised of a web of microfibers which may contain crimped macrofibers. The embossed dust collecting fabric of the invention has sufficient structural integrity to provide a commercially acceptable use life, yet it is sufficiently drapable, lofty and dust-attractive to be employed to remove dust from hard, smooth surfaces and other areas where conventional dust collecting fabrics are employed.

The working face of the nonwoven fabric is embossed to a limited degree to provide integration of the normally fragile nonwoven web yet not interfere with its dust collecting ability. The areas on either side of the working face adjacent the side edges of the fabric may be more highly embossed to provide greater structural integrity sufficient to permit handling and installation of the fabric in certain dust mop frames having high shear or other holding means which could damage the fabric.

Specifically the dust collecting fabric of the invention is characterized by being a disposable, drapable, embossed nonwoven web, at least about 1 millimeter thick in the unembossed state, comprising entangled, discontinuous microfibers being capable of self-fusion under localized pressure and having an average diameter of about 10 microns or less, said fabric being embossed to provide a uniform pattern of embossing lines comprising about 2% to about 40% of its total surface area and to bond fibers at points where they touch one another without loss of individual fiber identity, said nonwoven web having an elongation value at maximum tensile breaking in the embossed state of at least about 25%.

The preferred dust collecting fabric of the invention is characterized by being an elongate disposable, drapable, embossed, binder-free nonwoven web at least about 2 millimeters thick in the unembossed state and comprising a homogeneous blend of (a) entangled, discontinuous microfibers having an average diameter of about 10 microns or less; and (b) crimped macrofibers about 5 to about 100 decitex, the weight ratio of said microfibers to said macrofibers in said web being about 3:7 to about 7:3, at least one of said macrofibers or said microfibers being capable of self-fusion under localized pressure, said fabric being embossed to provide (c) a first uniformly embossed area intermediate the side edges of said elongate web defining a dust collecting working face, said first embossed area characterized by having a uniform pattern of embossing comprising about 10% to about 40% of the total surface area of said working face; and (d) second uniformly embossed areas on either side of said first embossed area, each of said second areas being more highly embossed than said first area to provide a uniform pattern of embossing comprising about 25% to about 65% of the total area of said second areas, said embossing in said first and second areas being sufficient to bond fibers at points where they touch one another without loss of individual fiber identity.

The invention is further illustrated by reference to the drawing, wherein:

Fig. 1 is a top plan view of an embossed dust collecting fabric made in accordance with the present invention;

Fig. 2 is an enlarged cross-sectional view of a segment of the fabric shown in Fig. 1 taken at line 2—2;

Fig. 3 is a perspective view of a dust mop frame assembly having the fabric of Fig. 1 mounted for use; and

Fig. 4 is a sectional view of the mop frame shown in Fig. 3 taken at line 4—4.

Figs. 5—8 are top plan views of other embodiments of the embossed dust collection fabric made in accordance with the present invention showing variations in embossing patterns.

Fig. 1 of the drawing shows an embossed nonwoven fabric 10 made in accordance with the present invention comprised of a web formed of microfibers which preferably contains crimped macrofibers. The dust collecting area or working face 11 of fabric 10 is embossed to a limited degree to provide integration of the normally fragile nonwoven web to provide a pattern of continuous cross embossed lines 12 so that the web can withstand the forces normally associated with dusting operations. For this purpose, it has been found that sufficient integration of the web is obtained when the embossed areas are uniformly distributed over the working face in the form of lines which do not exceed about 7 mm in width and which embossed area comprises at least about 2 percent of the total surface area of working face 11. Embossing of working face 11 should not significantly interfere with its dust collecting ability. Appreciable reduction in dust collecting properties is noted when embossing exceeds about 40 percent of the total surface of working face 11. The preferred degree of embossing comprises about 10% to about 40% of the total surface of the working face.

The embossed lines of working face 11 may cross one another to define diamond shaped nonembossed dust collecting areas 13 which preferably are tapered or pointed at least in the direction of the main intended movement of the fabric in use so that the leading portion of each nonembossed area 13 is smaller than the body of the nonembossed area 13. Such tapering prolongs the life of the nonwoven fabric in use.

The embossing lines may be continuous, define individual, separated geometric shapes such as squares or circles, or may be a pattern of discontinuous straight or curved lines, such as straight lines (as shown in Fig. 6) or "J" shapes (as shown in Figs. 7—8) and the like. Embossing lines are sufficiently closely spaced to provide integration of the fibers of the web to prevent substantial fiber loss during use. For this purpose, the shapes or lines should preferably not be separated by more than about 2 cm and should not be aligned so as to provide a straight unembossed zone, which could provide a zone of weakness where the fabric could fail.

If needed, the fabric 10 may be more highly embossed on either side of working face 11 to provide highly embossed areas 14. Areas 14 may be more highly embossed to provide additional structural integrity to the fabric to make it capable of withstanding the forces encountered at the more high stress areas in use such as at the point of attachment where the fabric is fastened into certain types of mop frames. The embossed pattern in areas 14 may be in a continuous crossed arrangement as shown in Fig. 1, or a discontinuous arrangement, but are generally to a greater extent than working face 11, comprising up to about 65 percent of the total area of each of the more highly embossed areas 14. Mop frames with fabric attachment means that apply less shearing action to the edge of the dust cloth may not require more highly embossed side areas. One example of such an embossed pattern is shown in Fig. 8.

Any of a wide variety of embossing methods known in the art may be employed to provide the embossed patterns described above. For example, conventional heat and pressure may be used to impart the desired embossed patterns in the web. Other useful methods include impulse sealing with pressure which is similar to conventional heat and pressure but somewhat more refined in that the web is rapidly heated and cooled under pressure thereby minimizing any potential undesirable heat transfer, ultrasonic welding with pressure, rotary pressure embossing under ambient temperature, i.e., without heating, for example between appropriately shaped hard nip rolls, and the like. The latter method is the preferred method. Embossing methods using excessive pressure or excessive heat and pressure are to be avoided because such methods produce webs which have very little stretchiness or a low elongation value. Such webs will readily fail cohesively in use or as installation on the mop frame is attempted, with rapid wide-spread splitting of the fabric along the embossing lines.

Many different embossing patterns are possible and useful. the embossed lines in the working face of the fabric of the invention may define shapes which may include triangles, diamond shapes, squares, rectangles, polygons, pear-shaped areas, ovals, or may be in the form of a pattern of discontinuous lines which may be straight or curved, and the like.

The nonwoven web employed to produce the embossed fabric of the present invention is formed of entangled, discontinuous thermoplastic microfibers having an average diameter of about 10 microns or less which preferably may contain up to 70% by weight thermoplastic macrofibers of about 5 to about 100 decitex to provide additional loft to enhance entry of dust.

The weight ratio of microfibers to macrofibers in a preferred web is 3:7 to 7:3 to obtain a preferred balance of strength and loft in the resultant embossed web for use as a dust collecting element. The amount of macrofibers, however, should not be so great as to weaken the web. The tensile strength and the tear strength of the web decreases significantly when the macrofiber content exceeds 50 percent of the total fiber weight.

While microfiber webs containing macrofibers are preferred for use as dust collecting elements, webs containing 100% microfibers are also useful, particularly when embossed with patterns such as are shown in Figs. 7 and 8, but not when extremely highly embossed. A too highly embossed 100% microfiber web is characterized by having a low elongation value (i.e., less than about 25%) and thus would be subject to rapid cohesive failure as discussed above.

The microfibers should be capable of self-fusion under application of localized pressure to permit integration upon embossing. Preferably, both the macrofibers and the microfibers are capable of self-fusing.

The microfibers can be formed of any of a variety of fiber-forming thermoplastic materials including, for example, polypropylene, polyethylene terephthalate, polyethylene, polyamides, and other polymers known in the art. The preferred thermoplastic material for forming the microfibers is polypropylene.

The nonwoven webs may be prepared with microfibers which have been melt-blown (prepared by extruding molten fiber-forming material), solution-blown (prepared by extruding a solvent solution of fiber-forming material), or other means.

The macrofibers are crimped to provide loft in the resultant nonwoven web. Crimped fibers will have a continuous, wavy, curly or jagged character throughout their length. Crimping may be in a planar or three dimensional configuration. The number of crimps, i.e., complete waves or cycles, per unit fiber length may vary rather widely in the macrofibers useful in the invention. The macrofibers useful in the practice of the invention typically have more than about one-half crimp per centimeter and preferably have at least two crimps per centimeter. The amplitude or depth of the crimp fiber may also vary considerably for the crimped macrofibers useful in the present invention. Although amplitude and crimp are difficult to uniformly characterize in numerical values because of the random nature of many fibers, an indication of amplitude is given percent crimp. That quantity is defined as the difference between the uncrimped length, measured in the fully extended state, and the crimped length, measured by suspending the fiber sample with a weight attached to one end equal to two milligrams per decitext of fiber, divided by the crimped length and multiplied by 100. Macrofibers used in the present invention will generally exhibit an average percent crimp of at least about 15 percent, preferably at least about 25 percent.

The macrofibers, as a minimum, should have an average length sufficient to include at least one crimp and preferably at least three or four crimps. For ease of handling in preparing the web, when fully extended, the macrofibers typically average between about 2 and 15 centimeters in length, preferably between 2 and 10 centimeters.

The macrofibers may be formed of any of a wide variety of synthetic thermoplastic materials. The preferred macrofibers are crimped staple fibers formed of polyester, acrylic resin, polyolefin, polyamide, rayon, polyacetate, and the like. Such staple fibers are readily commercially available.

The thickness of the web, before embossing, should be at least 1 millimeter in order to obtain sufficient strength in the fabric and for the fabric to be adequately embossed. Preferably, the thickness should be at least 2 millimeters. The thickness will typically be less than 30 millimeters because, beyond this, the web becomes too bulky and is difficult to install in commercially available mop frames, although such webs are useful for collecting dust.

The nonwoven webs useful for preparing the embossed nonwoven fabric of the present invention and which contain macrofibers are prepared by introducing the crimped macrofibers into a stream of microfibers during the microfiber web formation process. A preferred method of producing this nonwoven web is disclosed in British Patent Application No. 32,224/77. Nonwoven webs which contain only microfibers are similarly made with the exception that no macrofibers are used.

One example of preparing a preferred nonwoven web suited for embossing to produce the embossed nonwoven fabric of the present invention involves simultaneously preparing melt blown microfibers while introducing macrofibers into the stream of freshly blown microfibers and depositing the collection of fibers on a suitable carrier. The microfibers may be produced using conventional equipment. The microfibers may first be prepared as a web, for example, by using a garnet machine or a "Rando-Webber" web-forming machine. The macrofiber web is then fed into the device which separates the macrofibers from the web and introduces them into the air stream which is employed to attenuate the microfibers to form the composite nonwoven web.

The web may also include other additives to improve its appearance, strength and/or performance. For example, impregnants may be added which improve the dust collecting ability and/or leave a slight residue to improve the surface being treated. Examples of such impregnants include oils such as hydrocarbon or silicone oil and paraffin wax.

Webs which are useful in the present invention may be selected on the basis of certain physical properties. Useful webs will be sufficiently strong to resist failure or pulling apart when mounted in a mop frame and used. For this purpose it is preferred that the web, in the unembossed state, have an average specific strength of at least about 0.3 (more preferably 0.6) as determined by averaging the specific strength in the longitudinal direction and in the transverse direction. Specific strength is the force required to pull a web apart divided by the weight of the web. A web which has been embossed should preferably have a specific strength of at least about 0.80, most preferably at least about 1.00.

The specific strength of a nonwoven web may be determined by weighing a 2.5 cm by 18 cm sample of the web, placing the narrow ends of the sample between 2.5 cm wide jaws of an "Instron" tensile testing machine, with the jaws 10 cm apart, and pulling on the sample at a rate of 30 cm per minute until the sample breaks. The maximum force in grams required to break the sample divided by

the weight of the sample in milligrams is the specific strength. Samples should be cut in both the transverse and longitudinal directions and the average determined.

The embossed nonwoven webs of the present invention should also have a moderate degree of stretchiness which permits at least slight stretching of the fabric without failure. For this purpose, the embossed nonwoven webs should have an elongation value in both the machine direction and the transverse direction at maximum tensile breaking strength of at least 25%, preferably at least 30%.

Elongation values are determined during the test for specific strength by measuring the distance the sample is stretched prior to its breaking at maximum tensile strength. In evaluating the examples hereinafter described, it was observed that the elongation value in the machine direction consistently fell below the elongation value in the transverse direction. Therefore, the elongation values reported herein with respect to the examples only reflect the lower value of that in the machine direction.

Webs which are useful in the present invention should not have appreciable drag or resistance when moved over the surface of the floor. Therefore, the useful webs of the present invention in the unembossed state preferably will have a dynamic coefficient of friction of less than about 1.3, preferably less than about 1.0.

The dynamic coefficient friction may be determined by positioning a 15 cm by 15 cm segment of the web under a 13 cm by 13 cm sled composed of a polyurethane foam adhered to a wooden block, placing a 454 gram weight on top of the sled to provide a total weight of 570 grams and pulling the sled at the rate of 50 cm per minute along a 60 cm section of vinyl or asbestos tile previously coated with three applications of commercially available floor polish (e.g., sold under the trade designation "Step Ahead"® by the S. C. Johnson Company), with the web sample between the tile surface and the polyurethane foam layer, and measuring the force required to pull. The dynamic coefficient friction is this force in grams divided by the total weight of the sled and any additional weight thereon.

Webs which are useful in the present invention will also be resistant to tearing. For this purpose, useful webs in the unembossed state preferably will have a tear strength of at least about 60 grams as determined by employing a Standard Elmendorf Model No. 60-100 Tearing Tester, using a 6.5 cm by 28 cm web sample. The tear strength in both the longitudinal and transverse direction of the web is measured and averaged.

Nonwoven webs which are useful in the present invention in the unembossed state preferably will have a loft or openness of at least about 30 cubic centimeters per gram. The loft may be determined by weighing a 10 by 20 centimeter section of the web, placing a 10 centimeter by 20 centimeter 0.3 millimeter thick aluminum plate exactly over the sample to avoid discontinuities in the web sample and measuring the thickness in centimeters at several points on the plate. The loft is a thickness in centimeters (less the thickness of the plate) times the area of the web in cm^2 divided by the weight of the web in grams.

Figs. 3 and 4 show an example of a commercially available dust mop frame 30 sold under the trade designation "Velmop"®. Such dust mop frames typically include an elongate flat-faced pad 31 which is preferably compressible (e.g., formed of foam rubber) mounted on a rigid back-up frame 32 to hold pad 31 in a planar configuration and holding means 33 to permit attachment of the ends 39 of a dust mop cleaning fabric 10, with the working face 11 of fabric 10 disposed on the flat face of pad 31. The mop frame may also include a universal joint 34 and a handle holder 35 into which a suitable handle 36 may be fitted. Holding means 33 in this case is provided by hinged projecting element 38 which frictionally engages sidewall 40 to hold fabric ends 39 therebetween. Many other dust mop frames are also known and commercially available, and that shown in Figs. 3 and 4 is merely provided as an illustrative example.

Examples

The invention is further illustrated by the following examples, wherein all parts are by weight, unless otherwise specified.

Example 1

A web, approximately 0.4 to 0.5 cm thick, before embossing, having a loft of 80—110 cm^3 per gram and a weight of 50 grams per square meter, was prepared by the method described in aforementioned of equal parts of 13 decitex, 3.4 cm polyethylene terephthalate macrofibers having 50% crimp and 0.2 to 4.3 micrometer diameter (average 1.2 micrometer) blown polypropylene microfibers. This web was embossed at ambient temperature sequentially between two sets of 25 cm diameter steel rolls. One set of rolls provided the embossed pattern on the working face while the other provided the more highly embossed pattern adjacent the edges. The working face was embossed with a diamond pattern, wherein each of the diamond shapes had a minor axis of 1.5 cm and a major axis of 4 cm to provide a pattern similar to that shown in Fig. 1.

The more highly embossed side edges of the web were embossed witrh a crosshatched pattern as shown in Fig. 1 of the drawing to provide square shapes 1.3 cm on edge with 0.24 cm wide embossed lines.

The embossing pressure ranged from about 60 kg per cm^2 to about 260 kg per cm^2 for the diamond-shaped pattern providing the embossed working face and about 270 to 600 kg per cm^2

for the more highly reinforced embossed pattern side edge portions. The web speed through the embossing rolls was approximately 4.5 meters per minute.

Example 2

A 0.4 to 0.5 cm thick web, before embossing, with a loft of 70 to 80 cm^3 per gram and a web weight of 55 grams per $meter^2$ was prepared of equal parts of the blown microfibers described in Example 1 and 53 decitex, 5.5 cm polyethylene terephthalate macrofibers having 51% crimp. The web was embossed to provide a pattern substantially as shown in Fig. 1 of the drawing to provide a nonwoven dust fabric.

Example 3

A 0.6 to 0.7 cm web, before embossing, having a loft of 140—160 cm^3 per gram and a web weight of 45 grams per meter was prepared of equal parts of 17 decitex, 3.8 cm nylon 6:6 having 45% crimp and 0.2 to 7.0 micrometer diameter (averaging 1.5 micrometers) polypropylene blown microfibers.

Examples 4—40

Other embossed nonwoven fabrics were prepared of the webs described in Table I below.

Table I

Ex. No.	*Web weight (g/m^2)*	*Macrofiber type*	*Decitex*	*Microfiber type*	*Weight ratio micro:macro*	*Other components*
4	50	PET[1]	17	Polypropylene	3:7	—
5	50—150	PET[1]	17	Polypropylene	7:3	—
6	50	PET[1]	17	Polypropylene	4:6	—
7	50—150	PET[1]	17	Polypropylene	1:1	2% Silicone oil[3]
8	50—150	PET[1]	17	Polypropylene	6:4	—
9	50	PET[1]	17	Polypropylene	1:1	2-1/2% Nylon fiber[2]
10	25	PET[1]	17	Polypropylene	6:4	—
11	50	PET[1]	17	Polypropylene	4:5	5—10% Polyethylene microfibers
12	50	PET[1]	17	Polyethylene	1:1	—
13	50	PET[1]	17	Polypropylene	1:1	2.5—5% Paraffin wax
14	50	PET[1]	27	Polypropylene	1:1	—
15	50	PET[1]	65	Polypropylene	1:1	—
16	50—150	PET[1]	225	Polypropylene	1:1	—
17	50—150	Nylon	55	Polypropylene	1:1	—
18	50	Nylon	17	Polypropylene	1:1	—
19	50—150	Nylon 6:6	65	Polypropylene	1:1	—
		PET	55			
20	50—150	Nylon 6:6	92	Polypropylene	1:1	—
		PET	124			
21	50—150	Nylon 6:6	72	Polypropylene	1:1	—
		PET	100			
22	100	PET	7	Acrylic	6:4	—
23	50	None	—	Polypropylene	1:0	contains no macrofiber
24	50	PET	17	Polypropylene	9:1	—
25	50	PET	17	Polypropylene	4:1	—
26	50	PET	17	Polypropylene	7:3	—
27	50	PET	17	Polypropylene	1:1	—
28	50	PET	17	Polypropylene	3:7	—
29	50	PET	17	Polypropylene	1:4	—
30	100	None	—	Polypropylene	1:0	contains no macrofiber
31	100	PET	17	Polypropylene	19:1	—
32	100	PET	17	Polypropylene	9:1	—
33	100	PET	17	Polypropylene	4:1	—
34	100	PET	17	Polypropylene	7:3	—
35	100	PET	17	Polypropylene	1:1	—
36	100	PET	17	Polypropylene	3:7	—
37	100	PET	17	Polypropylene	2.5:7.5	—
38	50	PET	17	Polypropylene	1:1	—
39	33	None	—	Polypropylene	1:0	contains no macrofiber
40	25	None	—	Polypropylene	1:0	contains no macrofibers

1. Polyethylene terephthalate
2. Sold under the trade designation "Elvamide"® by the E. I. DuPont Co.
3. Dimethyl silicone having a viscosity of 30,000 cs sold under the trade designation "Dow Corning"® 200 fluid by the Dow Corning Company.

Table II reveals the physical properties of certain webs in the unembossed state.

Table III compares the physical properties of certain unembossed webs with those after embossing.

It should be noted that the unembossed areas in the dust collecting working face of the nonwoven fabric of the invention will have substantially the same or slightly less loft and thickness as existed in the unembossed web before embossing. The unembossed areas in the more highly embossed side edge portions of the web may be, however, somewhat more compacted since this part of the web is not customarily employed for dust removal. This fact is reflected in Table III below. In that regard, compare the loft values for web Example I, before embossing, with a diamond pattern and with a crosshatched square pattern.

Table II

Ex. No.	*Embossing*	*Specific strength*	*Elongation (%) machine direction*	*Loft (cm^3/g)*	*Thickness (mm)*
23	None	1.67	48	30	1.5
24	None	1.41	53	44	2.3
25	None	1.29	55	54	2.5
26	None	0.92	56	85	4.2
27	None	0.74	49	98	4.6
28	None	0.36	46	104	4.7
29	None	0.26	47	101	4.5
30	None	1.79	42	30	3.0
31	None	1.64	46	32	3.1
32	None	1.45	46	45	4.8
33	None	1.21	43	53	5.3
34	None	1.05	44	63	6.3
35	None	0.63	46	84	8.9
36	None	0.36	49	92	8.6
37	None	0.28	49	87	6.6

Table III

Web Ex. No.	*Embossed pattern*	*Specific strength*	*Elongation (%) machine direction*	*Tear (grams)*	*Loft (cm^3/g)*	*Thickness (mm)*	*Coefficient of friction*
1	None	0.72	35	80	86	5.7	.94
1	Diamond	0.87	62	105	65	3.5	.92
1	Crosshatched square	0.82	40	120	34	1.8	.82
5	None	1.4	32	60	70	3.8	.73
2	None	0.99	36	80	80	4.3	.82
3	None	0.98	42	370	150	8.1	1.1
38	None	0.80	32	120	92	4.6	0.60
38	Fig. 5—Center	1.11	35	103	50	2.8	0.70
	Edges	1.82	27	336	26	1.5	—
38	Fig. 6—Center	1.07	38	119	52	2.6	0.65
	Edges	—	—	189	48	2.6	—
38	Fig. 7[1]—Center	1.40	31	114	44	2.3	0.64
	Edges	—	—	122	35	1.5	—
38	Fig. 7[2]—Center	1.23	43	116	50	2.4	0.60
	Edges	1.52	46	261	43	2.1	—
38	Fig. 7[3]—Center	1.03	38	113	52	2.3	0.63
	Edges	1.50	40	168	47	2.2	—
38	Fig. 8	1.23	43	116	50	2.4	0.60
30	None	1.79	42	205	30	3.0	1.00
30	Fig. 5—Center	1.83	36	220	22	2.7	0.85
39	Crosshatched square about 1 cm on an edge	3.90	19	20	48	1.6	0.51
40	None	1.33	50	—	30	0.85	—

1. Emboss lines 1.6 mm wide
2. Emboss lines 0.5 mm wide
3. Emboss lines 0.3 mm wide.

Evaluation of Dust Mop Efficiency

The embossed nonwoven fabrics of the present invention were evaluated as dust collection fabrics against a competitive nonwoven dust collection fabric sold under the trade designation

"Masslinn"® which consisted of hydrocarbon oil impregnated nonwoven rayon fabric. The evaluation consisted of mounting a 20 by 50 cm segment of the test dust collection fabric in a dust mop frame having a flat-faced pad. The dust mop was then employed to clean a vinyl asbestos test floor polished with four coats of commercial floor polish (sold under the trade designation "Step Ahead"® by the S. C. Johnson Co.) and covered with a weighed quantity of a synthetic dirt composition consisting of the following ingredients:

Ingredient	*Percent by weight*
walnut sawdust	25.0
carbon black	1.0
charcoal (6—14 mesh)	15.0
Al_2O_3 (60—80 grit)	6.0
Al_2O_3 (100—50 grit)	6.0
flint (180/00)	23.0
pumice	12.0
Fullers earth	12.0

The test floor had a total area of approximately 37 square meters divided into eight approximately equal rectangular areas of 4.6 square meters each. The test floor was first precleaned with a conventional cotton string type dust mop until no more than 0.2 grams of dirt was removed from the 37 square meter area. Then 1 gram of synthetic soil was uniformly scattered over one 4.6 square meter rectangular test area. The test mop was weighed before the cleaning and reweighed after to determine the amount of synthetic dirt held in the fabric after use. The amount of synthetic dirt pushed to the end of the 4.6 square meter test floor was also collected and recorded, after one pass over the 4.6 square meter area. The sum of the amount of dirt held and pushed was designated as the total dirt removed from the floor. The dust mop efficiency was obtained by multiplying the total removed dirt times 100 and dividing by the total amount of synthetic dirt initially applied to the test floor.

The mop was used again to clean a larger test floor area of the same floor type (but with only naturally occurring dust thereon) and reweighed after each 175 square meter cleaning pass to determine the use life of the fabric. The amount of naturally occurring dirt pushed and collected was also recorded for each 175 square meter area. The mop was then carefully shaken until successive weight readings, differed by less than 0.02 grams and the steps described above were repeated, adding a 1 gram sample of synthetic oil to the next 4.6 square meter test floor area, using the mop to clean the smaller test floor, as described above, and then using the mop to clean the larger test floor, and the cycle repeated until less than 0.15 grams of synthetic soil was picked up by the mop, or until the mop was used to clean more than 915 square meters of test floor. At this point, the mop was turned over, if it could be used on both sides, reweighed and the steps repeated until the mop again picked up less than 0.15 grams of dirt. If the mop was used on 2365 square meters without reaching this minimum usefulness, the test was also terminated.

The results of this test using the fabric of Example 1 and a Masslinn "control" fabric are shown in Table IV below.

Table IV

Area cleaned (sq. meters)	*Dust mop*	Dirt *held (g)*	*Dirt pushed (g)*	*Efficiency*
5 INITIAL	Control	0.49	0.29	0.78
	Ex. No. 1	0.28	0.20	0.48
185	Control	0.21	0.23	0.44
	Ex. No. 1	0.33	0.25	0.58
365	Control	0.22	0.26	0.48
	Ex. No. 1	0.23	0.26	0.49
550	Control	0.20	0.32	0.52
	Ex. No. 1	0.31	0.34	0.65
730	Control	0.10*	0.26	0.36
	Ex. No. 1	0.45	0.27	0.72
735 (NEW SIDE CONTROL)		0.42	0.29	0.71
915	Control	0.19	0.32	0.51
910	Ex. No. 1	0.45	0.30	0.75
915 (New Side Ex. 1)		0.42	0.20	0.62
1095	Control	0.08*	0.20	0.28
	Ex. No. 1	0.47	0.42	0.89
1275	Control	—	—	—
	Ex. No. 1	0.38	0.21	0.59

*Test terminated.

Table IV (cont.)

1460	Control	—	—	—
	Ex. No. 1	0.37	0.21	0.58
1640	Control	—	—	—
	Ex. No. 1	0.32	0.24	0.56
1820	Control	—	—	—
	Ex. No. 1	0.33	0.30	0.63
2000	Control	—	—	—
	Ex. No. 1	0.27	0.31	1.58
2185	Control	—	—	—
	Ex. No. 1	0.37	0.57	0.94
2365	Control	—	—	—
	Ex. No. 1	0.35	0.23	0.58

As can be seen from the results in Table IV, embossed nonwoven fabrics in accordance with the present invention are useful for cleaning more than twice the area of a commercially available nonwoven fabric dust mop.

Additional cleaning tests as described hereinabove immediately preceding Table IV were performed employing nonwoven fabrics of Examples 23—28 which were embossed with a pattern as shown in Figure 7. The results of such tests are set forth in Table V.

Table V

Area cleaned (sq. meters)	*Ex.*	*Dirt held (g)*	*Dirt pushed (g)*	*Total efficiency*
Initial 5	23	0.08	0.19	0.27
	24	0.02	0.26	0.28
	27	0.36	0.16	0.52
	28	0.37	0.20	0.57
185	23	0.20	0.26	0.46
	24	0.18	0.37	0.55
	27	0.19	0.26	0.45
	28	0.23	0.28	0.51
365	23	0.18	0.21	0.39
	24	0.25	0.16	0.41
	27	0.20	0.25	0.45
	28	0.22	0.16	0.48
550	23	0.19	0.10	0.29
	24	0.13	0.19	0.32
	27	0.20	0.28	0.45
	28	0.2	0.31	0.57
730	23	0.31	0.15	0.46
	24	0.17	0.28	0.45
	27	0.20	0.31	0.51
	28	0.18	0.24	0.42
910	23	0.16	0.20	0.36
	24	0.22	0.18	0.40
	27	0.23	0.29	0.62
	28	0.22	0.32	0.54
1090	23	0.17	0.31	0.48
	24	0.25	0.15	0.40
	27	0.19	0.32	0.51
	28	0.19	0.17	0.36
1095 NEW SIDE	23	0.21	0.13	0.34
	24	0.17	0.19	0.36
	27	0.31	0.30	0.61
	28	0.21	0.20	0.41
1275	23	0.31	0.09	0.40
	24	0.21	0.25	0.46
	27	0.29	0.28	0.57
	28	0.18	0.27	0.45
1460	23	0.23	0.29	0.52
	24	0.20	0.18	0.38
	27	0.25	0.28	0.53
	28	0.13	0.27	0.40

Table V (cont.)

	1640	23	0.29	0.08	0.37
		24	0.19	0.18	0.37
		27	0.22	0.32	0.54
	1820	23	0.24	0.18	0.42
		24	0.20	0.72	0.42
		27	0.26	0.22	0.48
	2000	23	0.24	0.21	0.45
		24	0.25	0.22	0.47
		27	0.24	0.32	0.56
	2185	23	0.23	0.17	0.40
		24	0.19	0.15	0.34
		27	0.26	0.40	0.66

Claims

1. Fabric especially suited for use as a dust cloth or as a dust mop cleaning element, said fabric comprising a disposable, drapable, embossed nonwoven web, said web being at least about 1 millimeter thick in the unembossed state and comprising entangled, discontinuous microfibers being capable of self-fusion under localized pressure and having an average diameter of about 10 microns or less, said fabric being embossed to provide a uniform pattern of embossing lines comprising about 2% to about 40% of its total surface area and to bond fibers at points where they touch one another without loss of individual fiber identity, said nonwoven web having an elongation value at maximum tensile breaking in the embossed state of at least about 25%.

2. The fabric of Claim 1 wherein said embossed nonwoven web has a specific strength of at least about 0.80, and said nonwoven web in the unembossed state has a tear strength of at least about 60 grams, a loft of at least about 30 cubic cm per gram and a dynamic coefficient of friction with respect to polished vinyl or asbestos tile less than about 1.3.

3. The fabric of Claim 1 wherein said nonwoven web is binder free.

4. The fabric of Claim 1 wherein said nonwoven web comprises up to about 70 by weight crimped macrofibers fibers of about 5 to about 100 decitex per 100 parts total weight of microfibers and macrofibers.

5. The fabric of Claim 1 wherein said nonwoven web is more highly embossed adjacent its side edges to provide in said more highly embossed areas a uniform pattern of embossing comprising from about 3% to about 65% of the total area therein.

6. Fabric especially suited for use as a dust cloth or as a dust mop cleaning element, said fabric comprising an elongate disposable, drapable, embossed, binder-free nonwoven web,

said web being at least about 2 millimeters thick in the unembossed state and comprising a homogeneous blend of:

(a) entangled, discontinuous microfibers having an average diameter of about 10 microns or less; and

(b) crimped macrofibers about 5 to about 100 decitex, the weight ratio of said microfibers to said macrofibers in said web being about 3:7 to about 7:3, at least one of said macrofibers or said microfibers being capable of self-fusion under localized pressure,

Said fabric being embossed to provide

(c) a first uniformly embossed area intermediate the side edges of said elongate web defining a dust collecting working face, said first embossed area characterized by having a uniform pattern of embossing comprising about 10% to about 40% of the total surface area of said working face; and

(d) second uniformly embossed areas on either side of said first embossed area, each of said second areas being more highly embossed than said first area to provide a uniform pattern of embossing comprising about 25% to about 65% of the total area of said second areas, said embossing in said first and second areas being sufficient to bond fibers at points where they touch one another without loss of individual fiber identity.

7. The fabric of Claim 6 wherein said crimped macrofibers are on the order of about 5 to about 100 decitex, exhibit an average percent crimp of at least about 15% and are between about 2 and 15 cm in length.

8. The fabric of Claim 6 wherein said macrofibers are formed of a thermoplastic material selected from the group consisting of polyester, acrylic resin, polyolefin, polyamide, rayon and polyacrylate.

9. The fabric of Claim 6 wherein said web, before embossing has a thickness between about 1 and about 30 millimeters.

10. The fabric of Claim 6 wherein said microfibers are formed of a material selected from the group consisting of polypropylene, polyethylene, polyethylene terephthalate and polyamides.

11. The fabric of Claim 6 wherein said web, in the unembossed state, has a specific strength of at least about 0.3, a dynamic coefficient friction of less than 1.3, a tear strength of at least 60 grams and a loft of at least 30 centimeters per gram.

12. A dust mop having a handle attached to a mop frame which includes a back-up pad having an

elongate flat face upon which a fabric dust mop cleaning element is positioned and fastening means for holding said fabric dust mop cleaning element in place on said back-up pad, the improvement comprising employing the fabric of Claim 1 as said fabric dust mop cleaning element, said fabric being dimensioned to position said dust collecting working face intermediate the side edges of the elongate flat face of said back-up pad flat face.

13. A fabric for in a dust cloth or mop substantially as described herein with reference to and as illustrated by Figures 1 and 2 of the accompanying drawings.

14. Fabrics substantially as described in the examples herein.

15. A dust mop substantially as described herein with reference to and as illustrated by Figures 3 and 4 of the accompanying drawings.

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